The Pedagogical Orientations of Pre-Service South African Physical Sciences Teachers

Abstract

To teach science successfully, teachers need to have not only good content knowledge but also knowledge of how to translate this into appropriate teaching approaches for specific topics and for a particular group of learners. The study investigated the pedagogical orientations of South African physical sciences pre-service teachers. A key dimension in science teaching is pedagogical orientation. The term 'orientation' refers to teachers' knowledge and beliefs for teaching science. A quantitative survey approach was applied in this study. Pre-service teacher's pedagogy preferences were measured using a questionnaire instrument comprising of items that portrayed actual teaching scenarios for particular physical sciences topics. Each item provided four alternative teaching method options, and students were required to select the option they considered to be most appropriate and the most inappropriate. Each option corresponded with a particular pedagogical orientation that was based on a framework developed by a team of researchers at Western Michigan University. The pre-service teachers were also required to justify each choice. Based on the pedagogical orientation choices made, the instrument yielded quantitative data that was analysed descriptively in order to establish the preferred pedagogical orientations of the pre-service teachers. The results of the analysis revealed that pre-service teachers exhibited a strong preference for learner-centred teaching approaches that aligned with guided inquiry and open discovery pedagogical orientations, while a much smaller group of students preferred the teacher-centred direct didactic and direct interactive orientations.

Keywords: Pedagogical Orientations, Pedagogical Content Knowledge and Pre-service teachers

Extended summary

The most critical aspect of teacher education is acquiring different ways of teaching science for conceptual understanding (Cobern, Schuster, Adams, Skjold, Muğaloğlu et al., 2014). In university methodology courses, pre-service teachers are exposed to reading materials, observing each other teaching during microteaching or creating lesson plans for assessment purposes, however, they have limited exposure to a variety of approaches in teaching science topics (Cobern, et al., 2014).

The aim of this study was to explore the pedagogical orientations of pre-service physical sciences teachers' towards their classroom teaching. In order to realise the aim of the study, the following research question was set:

i. What are the pedagogical orientations of pre-service physical sciences teachers?

The study was underpinned by pedagogical content knowledge (PCK). PCK is an amalgam of pedagogical and content knowledge that makes possible the transformation of this two knowledge into most powerful, teachable forms to formulate subject and make it comprehensible (Shulman, 1987). Within PCK, Magnusson, Krajcik, and Borko (1999) define orientation as "teachers' knowledge and beliefs about the purposes and goals of teaching

science at a particular grade level" (p.97). Orientations play a pivotal role in shaping teachers decisions and goals for science in the classroom.

This research on measuring pre-service teacher's pedagogical orientations is based on the framework developed by a group of researchers at the University of Western Michigan who produced a set of case-based assessment items that present realistic teaching scenarios for a science topic (Cobern et al., 2014). Pre-service teacher's pedagogy preferences are measured using a teaching scenario assessment item, which portrayed an actual teaching scenario for a particular physical sciences topic and provided four alternative teaching method options. Students were required to select the option they thought was the most appropriate and most inappropriate then provide reasons for each. Below is a classification of pedagogical orientation types based on the framework developed by Cobern et al. (2014).

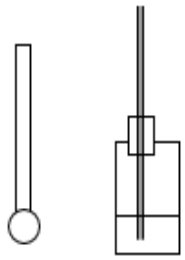
Didactic Direct	Teacher presents the science concept or principle directly and explains it. Illustrates with an example or demonstration. No student activities, but teacher takes student questions and answers them or clarifies.
Active Direct	Same as the direct exposition above initially, but this is followed by a student activity based on the presented science, e.g. hands-on practical verification of a law.
Guided Inquiry	Topics are approached by student exploration of a phenomenon or idea, with the teacher guiding them toward the desired science concept or principle arising from the activity. Teacher may explain further and gives examples to consolidate. Questions are dealt with by discussion.
Open Inquiry	Minimally guided by the teacher, students are free to explore a phenomenon or idea in any way they wish, and devise ways of doing so. Teacher facilitates but does not prescribe. The process is generally considered the most important thing and students present what they found.

Figure 1: A description of each of the Pedagogical Orientations *Adapted from Cobern et al. (2014).*

The following is an example of a scenario that is depicted in an item:

Thermometers and how they work

Mr Ndlovu is developing a science lesson for his students, in which he would like them to acquire an understanding of thermometers and how they work. He has real thermometers available. He also has materials that students could use to assemble their own basic thermometers (small bottle as a bulb, cork with hole, straws and coloured water). Mr Ndlovu considers four different ideas about how to structure and teach the lesson.



Thinking about how you would teach, which one of the following is most similar to the approach you would take?

A. Start by telling students that today they will make a mystery device, see how it behaves and then try to conclude what it might be used for. Then show the students how to put their materials together, and have them explore what happens to the water column in the straw when they put the bulb in cold and hot water. Ask them to suggest what they have 'invented' and what it can be used for. Finally, wrap up with a discussion of thermometers and how they work.

B. Write the lesson title 'Thermometers' on the board and draw a thermometer diagram. Then explain how a thermometer works and answer student questions. Conclude by placing a real thermometer in the cold and hot water and showing students how the thermometer reading changes.

C. Ask the class what they know about thermometers. List student responses on the board, and then working from some of their ideas, draw a thermometer and explain how it works. Then have students use thermometers at their tables, measuring the temperatures of cold and hot water.

D. Start by telling the class that today they will discover something for themselves. Each group will have a bottle, cork, straw and coloured water, plus containers of hot and cold water. Show them how to assemble the materials but give no further guidance. They can explore as they wish and come up with ideas, which they can then report to the class.

The teachers were then provided with four options from which to choose, with each option aligning with a particular pedagogical orientation. For example, an option that aligned with guided inquiry was "option D".

Using a quantitative survey approach, the questionnaire was administered to a sample comprised of 45 Bachelor of Education 4th year students (physical sciences specialisation) at a South African university. Data in the form of options made were arbitrarily coded as follows: 1= didactic direct; 2 = direct interactive; 3 = guided inquiry and 4 = open inquiry. Thereafter the coded data were analysed by employing descriptive statistics. Table 1 below reports the pedagogical orientations of pre-service teachers.

Results

Table 1: Distribution of pedagogical orientations physical sciences pre-service teachers

	Direct didactic (%)	Direct interactive (%)	Guided inquiry (%)	Open discovery (%)
Most appropriate	4	7	53	36
Most inappropriate	73	9	9	9

The results above reflect that students' preferred pedagogical orientation is guided inquiry with 53% of all choices made corresponding with this orientation. A significant number of choices (36%) were classified as "open discovery". In contrast, a relatively small percentage were direct didactic (4%) and direct interactive (7%) under most appropriate. Overwhelmingly, the students regarded direct didactic (73%) as inappropriate. The proportionality distribution is represented graphically in the stacked graphs below (Figure 2).

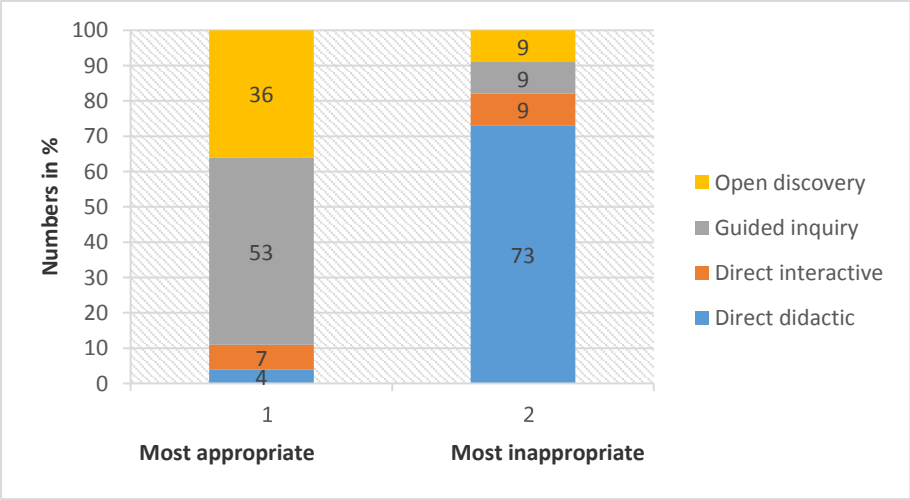


Figure 2: Representation of most appropriate and inappropriate pedagogical orientations choices

In conclusion, the results of the analysis revealed that pre-service teachers exhibited a strong preference for learner-centred teaching approaches that aligned with the guided inquiry and open discovery pedagogical orientations, while a much smaller group of students preferred the teacher-centred direct didactic and direct interactive orientations. In South African, inquiry-based learning forms a strong focus of the national curriculum, and is hence emphasized strongly in the science teacher education programmes at all universities. The findings of this study reflect that students embrace a preference for this orientation. It is recommended that further research be conducted in order to establish whether in practice these teachers reflect an orientation that aligns with this preference. Future studies may also want to explore how contextual factors such as class size, availability of resources and

assessment policy influence the displayed pedagogical orientation of pre-service teachers when they do their school practicum.

The contributions from the study are very important, as it has identified the preferred pedagogical orientations of pre-service physical sciences teachers. Understanding pre-service science orientations will lead to understanding the factors that may contribute to these orientations and the results will afford professional developers and policy implementers the knowledge needed when planning curriculum in particular in developing countries like South Africa. Furthermore, there is a growing advocacy for inquiry-based instruction, which is in line with the conference theme.

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